Why do we need Knowledge Management?

A Defence R&D Canada Perspective

Susan McIntyre
DST Pol 9

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1. Introduction

1.1 Background

Defence R&D Canada is a knowledge[1] enterprise. From its inception, it has collected, created, shared, and disseminated scientific knowledge and knowledge products within local, national and international communities. For over 50 years, Canadian defence science employees have advanced creativity and innovation within an organization that places high value on scientific excellence and cooperation. Defence R&D Canada's culture, structure and reward systems have evolved over the years to reflect these core values. New trends in the rapidly changing technological revolution and global economy reinforce the need for their pursuit. As we enter the 21st century, the pace of technological change combined with an increasingly competitive business environment place additional pressure on the Agency to maintain its innovative edge. Conversely, new technologies and knowledge management (KM) theories offer opportunities to explore new ways of capturing and using knowledge to ensure continued innovation, cooperation and excellence.

In scientific and technological (S&T) organizations such as Defence R&D Canada, the most important resources have always been in the minds and interactions of the employees. Until the recent past, this intellectual capital was reasonably assured through workforce stability. Employees would spend all or most of their careers within a single organization. New employees entering the workplace would work over time with seasoned colleagues to acquire the experience and knowledge required to eventually assume similar leadership roles. This is no longer a viable model. Attrition trends due to downsizing, a mobile workforce and the impending retirement bubble threaten the stability of the corporate memory. The "corporate memory" has either left or will leave, often before formally sharing his or her knowledge with the organization that most values it. Remaining employees then often find themselves further isolated as solitary subject experts without access to the knowledge that is resident in other colleagues, clients or external sources. Compounding it all is the rising proliferation of the quantity of available information and a decreasing ability to effectively filter that which is pertinent.

With the mission of the Defence R&D Canada being to provide expert scientific and technological knowledge and leadership to the Canadian Forces (CF) and the Department of National Defence (DND), sustaining long-term innovation in core competencies will be fundamental to the Agency's ability to attaining technological and knowledge advantage for the CF. This capability will be dependent upon creating systems that will facilitate the gathering and sharing of knowledge between employees, clients and external sources. It will require new methods of transforming intellectual capital into usable knowledge forms. It will also require conditions and a working environment that breed creativity and encourage a culture of intellectual growth and continuous learning. By focussing "on ways to manage how … knowledge is used, and to build systems and

[1] Knowledge is defined in the Webster's Third New International Dictionary as: "the fact or condition of knowing something with a considerable degree of familiarity gained through experience of, or contact or association with the individual or a thing so known"

mechanisms to facilitate the expression and thereby sharing of ideas and know-how,"[2] the Agency will find ways to share existing intellectual resources in creative ways. Such an approach will have to take into account both tacit knowledge, that which resides undocumented within the individual and in the corporate collective, and explicit knowledge, which has been "codified" into a more accessible form.

In response to the *Revolution in Military Affairs* and the *Canadian Defence Strategy for 2020*, Defence R&D Canada's *Technology Investment Strategy* and the *ADM(S&T) Business Plan 2000/2001* have targeted knowledge management as one of the areas for growth and investment over the next decade. In addition to developing the technological capabilities in this area, the Agency recognizes the potential for KM in the corporate management sphere. The Agency will work cooperatively with the Departmental Directorate of Information and Knowledge Management and has made plans to create its own directorate to address corporate knowledge and information management issues.

A Knowledge Management Working Group was formed in February 2000 to examine how knowledge management principles could be applied to enhance the use of existing forms of expertise and knowledge, both by the Agency and by its clients. The Working Group was tasked to examine methods of capturing and leveraging S& related knowledge for improved productivity and innovation within Defence R&D Canada and for knowledge collaboration and support within the broader defence S&T community, and to make recommendations for a way ahead. This paper examines the business challenges of the Agency, defines knowledge management and suggests how KM might help the Agency addresses these challenges.

1.2 Defence R&D Canada Vision, Mission and Values

Knowledge and its use are fundamental to Defence R&D Canada's vision and mission. The vision of the Agency is "to provide science and technology leadership to the Department, the Canadian Forces, and the Canadian defence industrial base." The Agency's mission is to:

- facilitate and enhance the ability of decision-makers to make informed decisions on defence policy, force generation and procurement by providing expert S&T knowledge,
- contribute to the success of military operations by pursuing R&D activities that provide improved support, knowledge, protection and response to potential threats,
- enhance the preparedness of the Canadian Forces by assessing technology trends, threats and opportunities and by exploiting emerging technologies;
- support government objectives by contributing to the creation and maintenance of a Canadian defence S&T industrial capability that is internationally competitive; and
- conduct S&T projects for clients external to DND, in order to assist the Agency in developing and maintaining its defence-related technological capabilities.

[2] Koulopoulos and Frappaolo 1999, p. 18.

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To realize the vision and achieve the mission elements, the Agency must enhance its ability to capture, disseminate and further its knowledge for three primary groups: the Defence R&D Canada team, clients and partners. The Agency must first be able to ascertain the contents and potential of its own knowledge base, capture existing, currently untapped sources and present them in ways that will enhance the innovative ability of the employees. Second, these knowledge sources, in addition to other external, relevant sources, must be exploited and structured or packaged for the benefit of the clients, the CF and DND. As a knowledge source and creator, the Agency must look to enhanced methods of exploiting intellectual capital and providing expertise to clients. Third, the Agency must work closely with industrial, university and allied partners to exchange and exploit shared information and knowledge resources.

The ability of the Agency to successfully develop knowledge systems will require a working culture that enhances and encourages the sharing of knowledge among the participants. The Agency currently holds cultural values that should position it to successfully implement knowledge systems. It is an organization that values the importance of providing responsive, efficient and cost-effective services to clients. It also values developing the skills and expertise of employees. Defence R&D Canada is committed to:

- scientific excellence, creativity, innovation and quality;
- providing the CF/DND with responsive, relevant, and cost efficient products and services;
- building a scientific centre of excellence;
- ensuring a workplace atmosphere of trust and respect, transparency, and accountability;
- developing and encouraging strong leadership, teamwork and commitment; and
- the well being of employees, building their skills and expertise, recognizing and rewarding their contributions, and building a workforce dedicated to competence and excellence.

It is commonly held that an organization must develop a culture that will allow for the effective implementation of knowledge systems. Defence R&D Canada's current cultural values can facilitate the acceptance of well-planned systems for knowledge sharing. *Leadership* is required to endorse and drive knowledge management initiatives. Senior leadership *commitment* is second only to employee *commitment* as the most critical factor in the success of knowledge systems. The *trust and respect* that the organization values can be reinforced by knowledge systems that provide a *transparency* of Agency activities. *Accountability and teamwork* must be built into the system and participation *rewarded* in order for it to succeed. Finally, the Agency's knowledge systems must be developed to support the values *of strong customer focus, creativity and innovation*. These would all contribute to the realization of an international centre of *excellence*.

1.3 Scope of the Strategy and Framework

A KM Strategy and Framework will be created for the way ahead for Defence R&D Canada to use KM to contribute to the improvements of products, services and client relationships. It will focus on how knowledge management principles can work within the Defence R&D Canada business strategy to enhance innovation and productivity. A Business Case will provide a cost/benefit analysis for proposed actions and an implementation plan will concentrate on the corporate management requirements of the Agency.

The Working Group will also address the objectives under the Technology Outlook Thrust Project 20ae, "Methods for Capturing and Using S&T Knowledge to Advance Defence Strategy 2020. " A second facet of the group will explore KM as it pertains to the Defence S&T community within the CF and DND and how Defence R&D Canada could exploit, transfer and share its expertise and knowledge with clients. It will also explore opportunities and synergies with the allied defence community.

1.4 Goals and Objectives

While the goal of the Defence R&D Canada Knowledge Management Working Group is to develop a Knowledge Management Strategy and Framework that will support the S&T business strategy, vision, mission, and values of the Agency, the objectives are to accomplish this by devising a framework that strives to:

- improve levels of innovation;
- facilitate generative learning and adaptability;
- build upon the existing culture and natural communities of practice for knowledge sharing;
- integrate a knowledge sharing culture into the Agency through evangelism, incentives and rewards;
- identify and develop existing knowledge bases and repositories;
- extract and capture knowledge in an intuitive and timely method;
- anticipate and assess the external environment through competitive intelligence;
- facilitate business process efficiencies for innovation;
- leverage and, where appropriate, capture tacit knowledge through collaborative tools, knowledge repositories, expertise and skills directories and best practices; and
- leverage existing and potential defence S&T knowledge for the benefit of DND, the CF, and partners.

1.5 Business Aims of KM

Knowledge management is about innovation and the ability to innovate more quickly than the "competition." As with other publicly funded agencies, this means that Defence R&D Canada must be proactively responsive to the needs of its clients and the Canadian people. The innovative edge is the single most important factor in keeping the CF and DND technologically prepared for future scenarios. Knowledge management principles,

when aligned with the Defence R&D Canada business strategy, present opportunities to improve Agency performance through better management of existing and potential intellectual capital and knowledge resources. Table 1 lists some of the common KM business drivers and rates their importance for the main Defence R&D stakeholders as they relate to defence S&T knowledge. They are rated as being either, V (Very Important), S (Somewhat Important), or L (Less Important).

KM Drivers	Employees	Managers	DRDC Team	Clients	Partners
"To know what we know": access to the organization's collective knowledge	V	V	V	S	L
Equitable, timely and efficient distribution of knowledge across the whole organization	V	V	V	L	L
To learn from past experiences	V	V	V	L	L
Continuous learning, constant renewal and rejuvenation of the workforce	V	V	V	L	L
Time, space, incentives, recognition and rewards for knowledge sharing	V	V	V	L	L
Empowered, innovative, satisfied employees	V	V	V	L	L
Interoperability of knowledge and information systems	V	V	V	V	V
Increased productivity; time-to-field compression	S	S	V	V	V
Linkage between knowledge, business strategy and information technology for timely informed business decisions	L	S	V	L	L
Connectivity and convergence of diverse functions; locating and sharing expertise in unrelated or unfamiliar fields	S	V	S	L	L
Retain, gather, access skills and expertise from across the organization for response to operational demands and emerging technologies	S	V	V	V	L
Develop expertise quickly in new employees and emerging technologies: reduce costs by maximizing knowledge and skills management	S	V	V	S	L
Virtual collaboration and remote teaming on agency, departmental, national and international levels	V	V	V	V	V
Knowledge applications for improved and new client services and products	S	S	V	V	S
Disseminate knowledge for strategic, procurement and planning purposes	L	L	V	V	L
Capture knowledge (often tacit) of project teams	S	S	V	L	L
Get "just the right" knowledge	V	V	S	S	S
Avoid repeated and often expensive mistakes	V	V	V	V	V
Avoid unnecessary reinvention	V	V	V	V	V

Monitoring and forecasting competition, new and emerging technologies, opportunities	S	V	V	V	S
Leveraging existing knowledge for increased returns	L	S	V	S	L
Upward innovation spiral	S	S	V	V	S

Table 1[3]

2. The Business Problem

2.1 Defence R&D Canada Key Business Objectives and Strategy

The Defence *Strategy for 2020* identifies among its change objectives the need to modernize, i.e., to "field a viable and affordable force structure trained and equipped to generate advanced combat capabilities that target leading edge doctrine and technologies relevant to the battlespace of the 21st century." To this end, the Agency has committed itself to focus on the operational needs of the Department, capitalizing on leading edge technologies while exploiting Canadian technical expertise. This includes the intent to exploit Canadian technical expertise in the area of information and knowledge management and specifically to capture the expertise and knowledge resident in the Agency.

The ADM (S&T) Business Plan for 2000-2001,[4] therefore, states that under Business Line Four, the "Defence R&D Agency will be known for its knowledge and expertise in the R&D industry". The essence of information and knowledge management is to help decision-makers make informed decisions on defence policy, force generation and procurement by providing expert S&T knowledge. The main goals include: to increase the capacity of DND and CF decision-makers, and others, to absorb, understand and integrate S&T knowledge into planning and operations; to build the innovation and decision-making capacity of DND; and to leverage knowledge through the Defence S&T Network." Under Business Line One, the Technology Investment Strategy identifies Knowledge management as a growth area in the next five years. Under Business Line Two, the Technology Outlook Thrust will identify a strategy for "Methods for Capturing and Using S&T Knowledge to Advance Defence Strategy 2020."

In this study, KM principles and tools will be evaluated for their potential use in addressing the four main business initiatives of the Agency for 2000/2001. The first objective, the implementation of the Defence R&D Agency, might benefit from KM opportunities in enhancing productivity, responsiveness to clients and client satisfaction. KM could address the second business objective, to take a strategic approach to HR management, through the introduction of practices that encourage collaboration, continuous learning, and innovation. The third objective, enhancing the Business Development Offices to facilitate the Agency's business, might be assisted by competitive intelligence tools and approaches. Finally, capturing and leveraging existing

[3] Some drivers adapted from Tiwana, 2000, p. 31
[4] ADM(S&T) Business Plan: FY2000-2001, 17 Dec 1999.

and future knowledge and expertise could assist in realizing the fourth objective in developing innovation in defence S&T.

2.2 Issues

What will assist Defence R&D in achieving its mission? The Business Plan identifies two performance gaps: 1) the rusting-out of facilities and obsolescence of equipment and 2) the lack of in-house expertise affecting the quality and quantity of R&D activities and products.

2.2.1 Addressing "Rust-Out" in R&D Information and Knowledge Management

The need to address the inability to adequately manage Defence R&D information and knowledge has been well documented in the past few years. The Information Management Plan, which was prepared for the R&D Branch in 1995[5], identified the following issues and problems:

- the need to treat information as a corporate resource;
- the need for project costing and tracking;
- poor Defence R&D visibility with CF clients;
- the DREnet as a "research" network did not always provide operational levels of services; and
- the multi-location nature of work incurred excessive travel.

At the November 1997 Thrust Leaders and Section Heads Workshop, a number of issues related to the management and use of information were identified: the need for integrated program planning and management tools, a records management policy, a tool for electronic filing (particularly for e-mail) and information sharing tools. These were outlined in the *Roadmap to the 21st Century*.[6] The document also recommended movement towards a knowledge management approach.

The Integrated Information Management Environment (IIME) was conceived as the system that would respond to the requirements identified by the Information Management Plan. While many of the requirements of the IIME remain valid, technology has advanced since its conception and any proposed implementation would require its re-evaluation. Since the recommendations of the *Road Map*, efforts have been made across the organization to rectify the need for better information management tools. Most recently, the Collaborative Program Management Environment (CPME) has been created and is still in the early stages of acceptance and use.

The development of information management in the Agency has been faced with challenges posed by the high rate of change in related technologies which result in difficulty in planning and implementing effective systems in a timely manner. Other

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[5] CGI. CRAD Integrated Information Management Environment (IIME) Prototype: Final Report, June 21, 1996.

[6] Road Map to the 21st Century: Building the Future Together, 1997.

challenges are personnel shortages, the high costs of implementing corporate-wide systems, and the decentralized approach to the management of these issues. Specifically some of the problems are:

- the collapse of traditional methods of capturing, organizing and retrieving corporate knowledge;
- the lack of replacement IM systems for managing electronic information;
- poor or non-existent filtering of information;
- organizational or technological barriers within the Agency to sharing, capturing, organizing and accessing knowledge and information;
- the lack of training to exploit existing systems; and
- the lack of a collective or centralized approach to gaining and providing access to external knowledge and information sources, particularly in innovative ways.

2.2.2 Addressing "Lack of expertise"

The reduction in defence spending in the last decade threatens the loss of defence S&T expertise within the Agency, nationally and among the allies. Attrition due to these cuts, the competition for valuable human resources in the high technology sector, and soon, the baby-boom retirement rush, will present tremendous challenges to the Agency as it tries to compensate for lost intellectual resources and corporate memory and it continues to move into emerging technologies.

The human resources (HR) challenges that Defence R&D Canada faces include:

- the ability to meet increasing client demands with reduced funding;
- attaining the skills to answer the shift from mature to emerging technologies;
- attracting and recruiting new skilled S&T staff in a competitive global economy;
- maintaining key human resources in a competitive HR environment;
- retraining employees for new technologies; and
- planning for the impact of the current demographic profile.

In addition, as a member of the government S&T community, the organization will continue to be called upon to participate in advancing the Canadian economy by contributing to S&T knowledge and wealth generation. If the expertise and knowledge base of the Agency were eroded, the organization would be prohibited from assuming the totality of its S&T leadership role in the defence community.

2.3 Enablers and Barriers

2.3.1 Enablers

Defence R&D Canada has developed a culture based upon the appreciation of creativity, innovation, quality and a dedication to serving its Canadian Forces and National Defence clients. Implementing new knowledge management systems will be enabled by a commitment to fostering these values through a continuous learning culture and one which rewards individuals and teams for meeting the business objectives. The adoption

of knowledge management practices would be enabled by the manifestation of these principles in the application of new systems: systems that facilitate and reward expertise, customer service, innovation, creativity, entrepreneurship, high quality products, sharing of information and knowledge, and continuous learning.

Other enablers that would support successful implementation would include:

- an Agency commitment to developing knowledge management systems;
- thorough strategic planning that aligns knowledge management systems with the business challenges and goals;
- a people-centric approach to knowledge management that meets the users at their own levels and needs;
- leadership and support from the top;
- availability of emerging technological tools that are more focused on content;
- global trends to information and knowledge sharing;
- the desire of scientific staff for more and accurate information and knowledge to address their research and development needs;
- a measurement system that will assess the effectiveness of new knowledge systems; and
- adequate and appropriate training for users.

2.3.2 Barriers

Potential barriers could risk the successful implementation of a knowledge system. They can be divided into two categories: general and specific to the Agency. General barriers would be created by building knowledge systems which:

- are based primarily upon technology rather than on systems of human interaction and needs;
- do not address motivations for knowledge sharing;
- do not account for the rapid pace of technological change in the development of knowledge and information based systems;
- do not anticipate future requirements and build upon past requirements; and
- do not accommodate future complexities.

Barriers to successful KM implementation specific to the Agency could include:

- competition for limited funds which constrain the organization's ability to implement large-scale technological knowledge systems requiring large infusions of funding;
- an inability to forge stronger links with S&T, knowledge and information management, and information technology partners in the Department which would effect the Agency's ability to become knowledge leaders;
- an inability to attain interoperability with the allies and cooperation with partners (to minimize duplication of effort and maximize the use of new technologies): and
- an unwillingness by the Agency to adapt knowledge-sharing solutions, architectures and policies.

3. Capturing and Leveraging Knowledge for S&T

3.1 Definitions

The definition of knowledge management must begin with a description of the knowledge pyramid. The transition from data to knowledge and beyond is illustrated in Figure 1 which illustrates how value increases and volume decreases while ascending. Facts, often referred to as "data" in knowledge management models, refer to

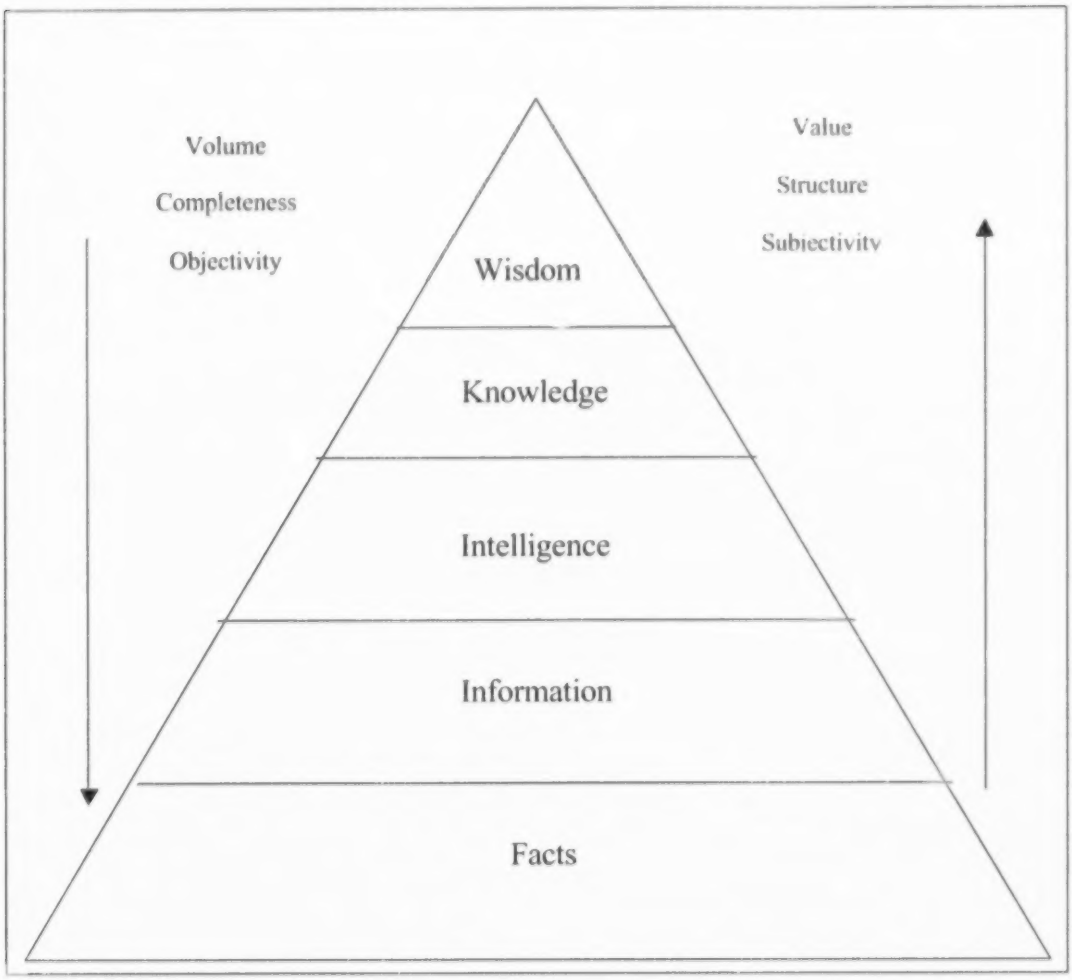

Figure 1: The Knowledge Pyramid

quantitative units or something given from being experienced.[7] When data or facts are structured and organized into a communicable form, information is created (e.g., words

[7] See Garigue, Robert. 1999, p. 24-28 for one discussion of this hierarchy.

into sentences). Inference transforms information into intelligence, which is an awareness of the aggregates arising from information. With certitude comes knowledge and finally with synthesis is wisdom. [8]

Knowledge, "the fact or condition of knowing something with a considerable degree of familiarity through experience, association or contact," [9] is best understood by dividing it into the categories of tacit and explicit.[10] Tacit is that which is understood, implied, and exists without being stated. It is informal, experiential, and difficult to capture and share. It is most often thought of as that which is held in the minds of individuals or in social relationships. Explicit is that which is stated in detail and leaves nothing merely implied. It is termed "codified" or "formal" knowledge because it is most often recorded. The challenge for knowledge management is how to capture and use both kinds of knowledge most effectively.

These concepts have been described in Figure 2[11] as ends of a continuum that might describe the knowledge of an enterprise. Intellectual capital can be defined as "the sum total of what your employees know. Its value is at least equal to the cost of recreating this knowledge."[12]

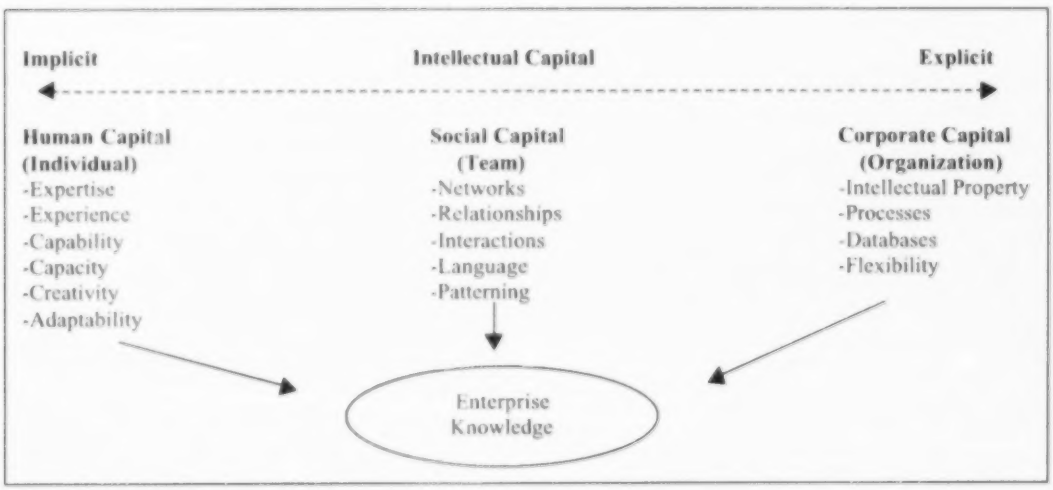

Figure 2: The Knowledge Continuum

How knowledge is actually created is fundamental to the development of knowledge management systems. Ikujiro Nonaka and Hirotaka Takeuchi[13] have developed a commonly used theory of organizational knowledge creation. In the model, shown in Figure 3, knowledge conversion occurs in four different modes.

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[8] Discussion taken from presentation by R. Barquin on "Barabba-Haeckel Model," 10 Apr 00.
[9] Webster's Third New International Dictionary. Springfield MA: Merriam-Webster, 1981.
[10] First introduced by Polanyi, Michael, 1966
[11] Bennet, Alex. 2000.
[12] Koulopoulos, 1999, p.32.
[13] This discussion is paraphrased from Nonaka and Takeuchi, 1995.

	Tacit Knowledge	*to* *Explicit Knowledge*
Tacit Knowledge	***Socialization***	***Externalization***
From Explicit Knowledge	***Internalization***	***Combination***

Figure 3 Knowledge Conversion

In the first mode of knowledge conversion, *socialization*, people share experiences and create tacit knowledge such as: shared mental models and technical skills. Socialization is often non-verbal and tacit knowledge is exchanged through experience. Apprenticeship is an example of how tacit to tacit knowledge conversion works where the apprentice works closely with the master to incorporate inherent skills and premises.

The second mode, *externalization*, is the "quintessential" knowledge creation process. It is where new knowledge is actually created. This is the conversion of tacit knowledge into explicit through the development and expression of concepts. Tacit knowledge becomes explicit by "taking the shape of metaphors, analogies, concepts, hypotheses or models." It occurs through dialogue or collective reflection or writing.

The *combination* mode is the conversion of explicit to explicit knowledge and involves combining different bodies of knowledge to create new knowledge. Existing concepts are reconfigured and knowledge is exchanged or combined through various media. Knowledge creation through formal education or training is an example of this third mode.

The fourth mode of knowledge conversion is *internalization*. It occurs when explicit knowledge is embodied into tacit knowledge in the form of shared mental models or technical know-how. Examples of this conversion are by reading, listening or "trying it out."

It is argued that effective organizational knowledge creation best occurs through a spiral process where knowledge is converted from tacit to explicit in a continuous and dynamic cycle. It is when tacit knowledge and explicit knowledge interact that innovation occurs. Knowledge creation is facilitated by deliberately managing the cycle. Organizational knowledge creation begins with socialization where individuals share experience and

mental models. It develops into externalization where individuals use metaphor or analogy to articulate hidden tacit knowledge that is otherwise hard to communicate. It moves into the combination phase for knowledge to be articulated, shared and expounded. Finally, individuals learn by doing and internalizing the new knowledge. The spiral begins again as the experience-based operational knowledge learned in the first cycle provides a larger knowledge base for continuous innovation and growth.

The challenge for organizations is how to maximize the ability to use knowledge creation in the continual growth and innovation of their employees and products. Knowledge management is a response to this challenge.

The definition of "knowledge management" varies greatly from one usage to another. It ranges from information technology solutions to cognitive interpretations to the dismissal of the term as an oxymoron. A selection of definitions for "knowledge management" was compiled for this project.[14] They include:

- Knowledge Management is the explicit and systematic management of vital knowledge and its associated processes of creating, gathering, organizing, diffusion, use and exploitation. It requires turning personal knowledge into corporate knowledge that can be widely shared throughout an organization and appropriately applied.[15]

- Knowledge Management is the collection of processes that govern the creation, dissemination and utilization of knowledge.[16]

- Corporate Knowledge Management is the process whereby knowledge seekers are linked with knowledge sources, and knowledge is transferred.[17]

- Knowledge Management is the management of the organization towards the continuous renewal of the organizational knowledge base—this means (e.g. creation of supportive organizational structures, facilitation of organizational members, putting [information technology] instruments with emphasis on teamwork and diffusion of knowledge (e.g. GroupWare) into place.[18]

- Knowledge Management is an audit of "intellectual assets" that highlights unique sources, critical functions and potential bottlenecks which hinder knowledge flows to the point of use. It protects intellectual assets from decay, seeks opportunities to enhance decisions, services and products through adding intelligence, increasing value and providing flexibility. Knowledge Management complements and enhances other organizational initiatives such as total quality management (TQM), business process re-engineering (BPR)

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[14] Waruszynski, Barbara. 2000.
[15] David Syrme Associates. 1997.
[16] Newman, Brian, 1996.
[17] Murray, T. ; Arthur J,. 1996.
[18] Bertels, Thomas, 1996.

and organizational learning, providing a new and urgent focus to sustain competitive position.[19]

- Knowledge Management is the explicit, systematic process of cultivating how knowledge is created, shared and translated into action. Significant attention must be given to know-how (competency), know-who (who's who), know-where (repositories) and know-why (motivation).[20]

- Knowledge Management is the ability to seek, identify, capture and reuse knowledge in such a way as it saves the organization time, effort and resources, as measured in terms of cost and quality.[21]

- Knowledge management is the leveraging of collective wisdom to increase responsiveness and innovation.[22]

Similar to this last definition, Defence R&D Canada has established that knowledge management refers to "capturing and leveraging knowledge for science and technology." This is accomplished by a management of the life cycle of knowledge. The cycle of scientific knowledge creation has traditionally included research or use, assimilation, creation, publishing, distribution, organization and storage, identification, and access.

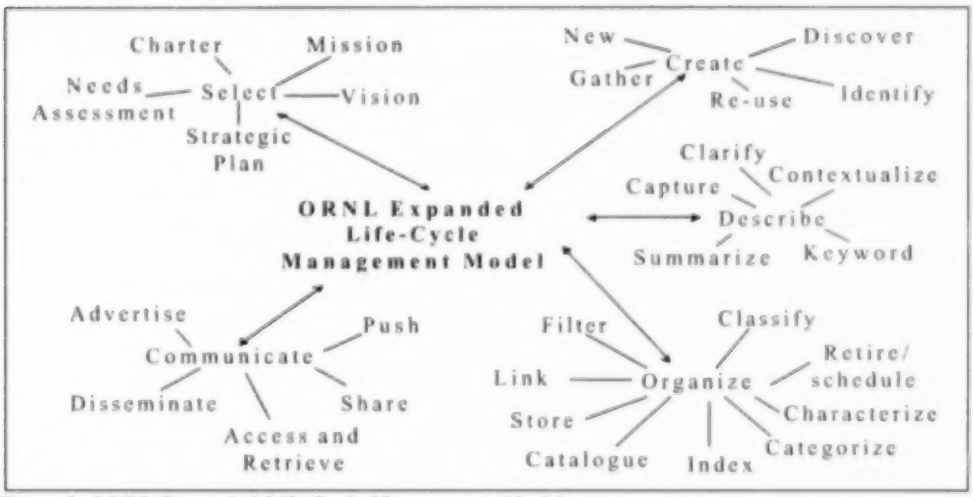

Figure 3: ONRL Expanded Life Cycle Management Model

A new life cycle model created by the Oak Ridge National Laboratory in the United States is presented in Figure 3.[23] The main events of the knowledge cycle are to select,

[19] Grey, Denham, 1996.
[20] Owens, David, 1999, p.26.
[21] TTCP JSA AG-9 "Winning Techniques in Technology Management: Knowledge Management," Presentation to NAMRAD. February 2000.
[22] Koulopoulos and Frappaolo, 1999, p. 38.
[23] Ashdown, Barbara, et al. 2000.

create, communicate, organize and describe. According to the Oak Ridge model, an organization must first determine what knowledge must be managed to achieve its business objectives. Sources to *select* knowledge include both business documents and needs assessments. Second, the model recognizes that the *creation* of knowledge includes the processes of identifying, discovering and gathering both new and old knowledge for the formulation of new or modified output. Third, once created, knowledge must be processed to be made as accessible and useful as possible. It is *described* in methods that enhance its usefulness by adding context or description in a variety of formats. In order for it to be effectively retrieved, knowledge must be *organized* in ways that users find most appropriate. Furthermore, the knowledge life cycle must be managed according to business requirements. Finally, knowledge must be *communicated* to all potential audiences and this requires the use of a variety of media. The model provides for the perpetuation of the knowledge life cycle but with a check at the top of the cycle to ensure that the knowledge being managed continues to be relevant to the business objectives of the organization. The Oak Ridge model might serve as a starting point for the development of a knowledge management model for Defence R&D Canada.

3.2 Premises

For the Defence R&D Agency, the primary focus of knowledge management will be the ability to foster innovation and learning for enhanced performance and results as defence S&T leaders. As knowledge "management" is as much a philosophy or an approach as it is a management tool, Defence R&D Canada will base its approach to knowledge management upon the premise that it must be culture and people-centric. The Agency recognizes that knowledge is within people and within the communities and social relationships of these people. Only by focussing on the employees and communities who use knowledge will these efforts be able to succeed. It is recognized that it is important to align the knowledge strategy with organizational goals to empower employees with information and knowledge and to create an environment that facilitates innovation.

What knowledge management cannot be expected to accomplish is as significant as what it can accomplish. Knowledge management is not technology-centric in that it is not driven by, but enabled by, technology. It has been demonstrated that technology alone cannot solve the issues that KM strives to address, nor is it sufficiently developed to do so at this time. Similarly, it is recognized that the focus of KM can not be on codifying tacit knowledge, as some suggest, because it is not possible to accomplish this in a comprehensive or useful way. Finally, since knowledge inherently becomes obsolete, it is not necessary to capture and store "everything," as "everything" does not necessarily have to be kept or is of value.

Knowledge management is concerned with supporting and administering the knowledge exchange connections between people. It strives to ensure that the total extent of the organization's expert knowledge is fully known and exploitable by the employees and management. Successful knowledge management requires the involvement of all facets of the organization and implementation requires the skills and resources of professionals in knowledge and information management, human resources, information technology

experts, the participation of content providers and users, led and inspired by senior leadership.

4. Knowledge Audit

4.1 Objective

The next step in the development of the KM Strategy and Framework will be to perform an audit of knowledge use and sources in the Agency to establish the current knowledge "management" situation and to identify enablers and barriers to effective knowledge use and leveraging. It will inventory and map knowledge sources. The audit will address the organization as a whole, i.e.; it will examine KM practices for the Agency rather than for sub-units of the Agency. The purpose of the knowledge audit will be to answer the following questions:

1. How well does the Agency manage its knowledge currently?
2. What are the current knowledge sources?
3. What are the knowledge needs of the organization?
4. How can it improve the use and leveraging of knowledge and, hence, innovation?

4.2 Methodology

To answer these questions, the audit will evaluate: [24]

1. the awareness of knowledge sources within the Agency and employees ability to locate that knowledge;
2. the Agency's ability to respond to requirements in a timely manner by locating knowledge sources internally and organizing skill sets when required;
3. the Agency's awareness of external barriers to knowledge and the ability to remove filters that prevent partnerships; and
4. the ability of the Agency to get its knowledge to the field (or market) responsively.

The methodology will employ interviews and focus groups of a cross section of employees in various functions. The data collected will be used to answer the first two questions directly: "how well does the Agency manage knowledge?" and "what are our knowledge sources?" The data will also be used to perform a needs analysis to determine the current knowledge requirements. It will also be used to perform a gap analysis to respond to the fourth question: "how can KM be improved in the Agency?" The audit will be performed in the early fall of 2000.

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[24] Methodology adapted from Koulopoulos and Frappaolo, 1999,p. 9

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